Detection of Dust for AIRS Processing

AIRS Science Team Meeting

Sergio De Souza-Machado, L.L. Strow, S.E. Hannon, and H.E. Motteler
UMBC Physics Department

May 3, 2005

Overview

- Dust retrievals/studies done at UMBC; using scattering RTA
- Dust flag
  - Q/A for Level 2 on single FOVS, avoid FOV processing
  - Retrieve dust parameters from CC'd FOVS?
  - Remove dust signal from radiances?
  - Flag limited to ocean scenes for now
- Conclusions

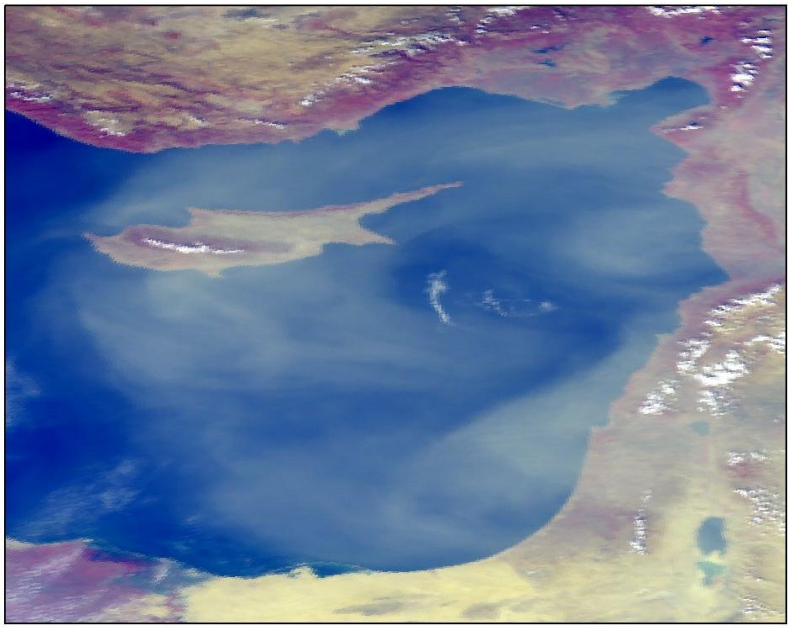
Introduction

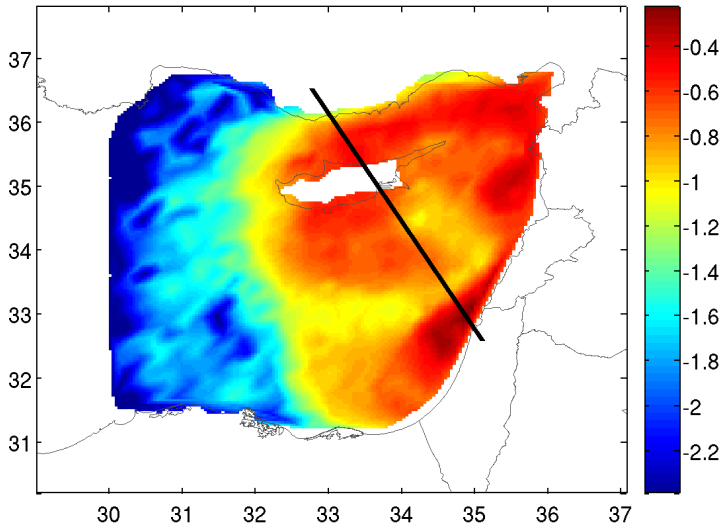
- Dust highly variable, can cover significant fraction of FOVs
- Dust often spatially uniform and passes through cloud clearing, signals can reach 5-10K or more
- AIRS retrievals compromised by dust
- Propose : dust flag, as well as code to estimate optical depth; avoid using scattering RTA??
- Validation against other instruments, intercomparing scattering codes

Scattering studies so far

- Fast two stream scattering code in SARTA (1 second/profile on 2 GHz machine)
- Analyzed various daytime granules with large dust storms
- Patterns of retrieved optical depths strongly resemble MODIS images (qualitatively and quantitatively)
- Varied the number of channels used in retrieval, as well as absolute vs split window differences, to optimize retrieval
- Did sensitivity studies for various parameters, such as refractive index, cloud top height and thickness, particle size

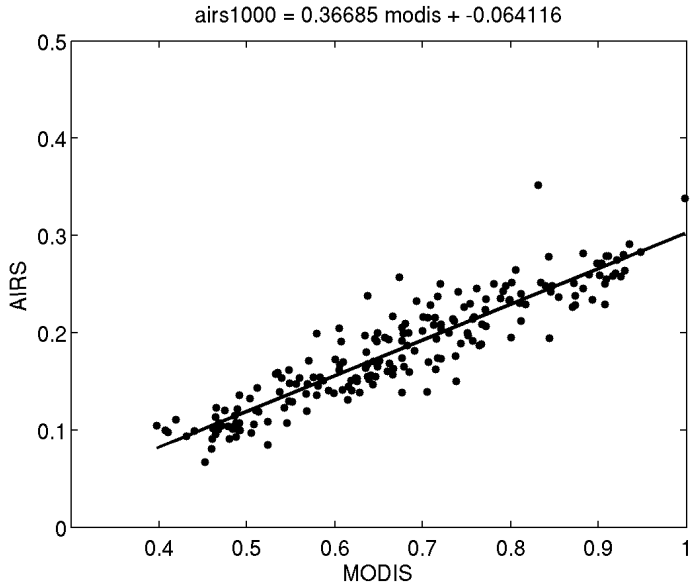
AIRS VIS image : October 19, 2002 (granule 107)

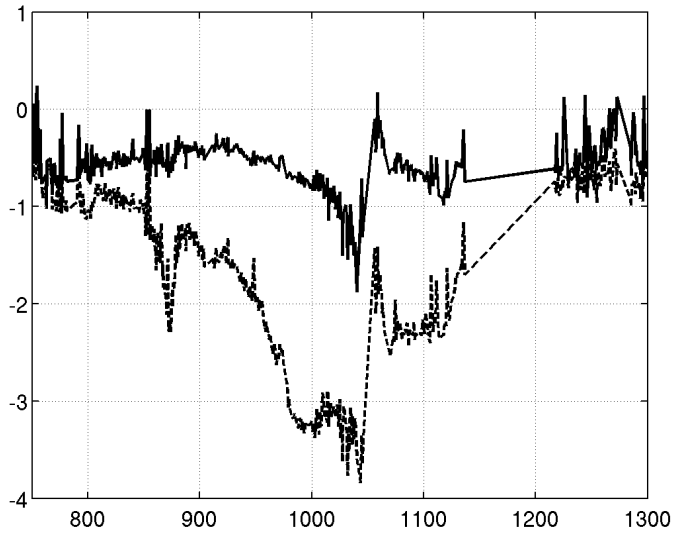




- Retrieved optical depths using about 15 thermal IR channels
- The log scale helps shows the streamers of dust on the westside of storm
- The log scale also shows the optical depths smoothly going to 0
- Line shows region above which MODIS retrievals were located

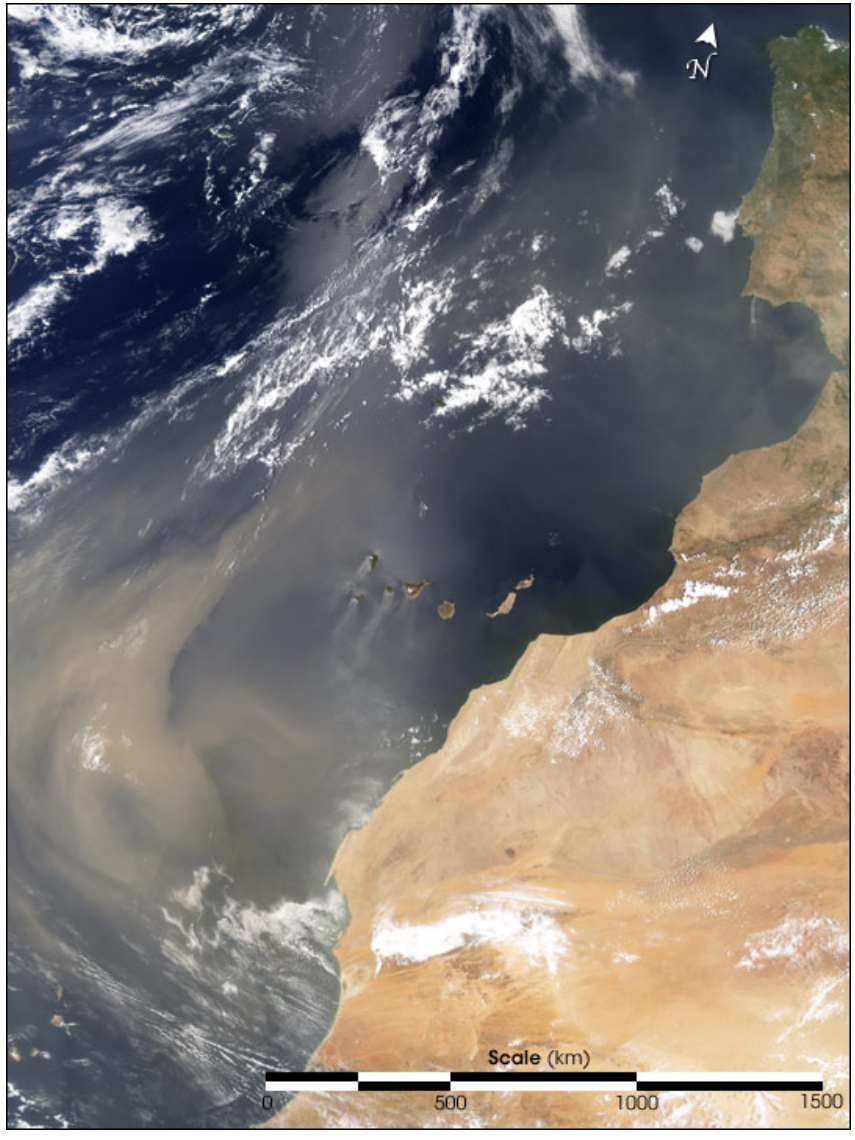
AIRS vs MODIS : October 19, 2002 (granule 107)





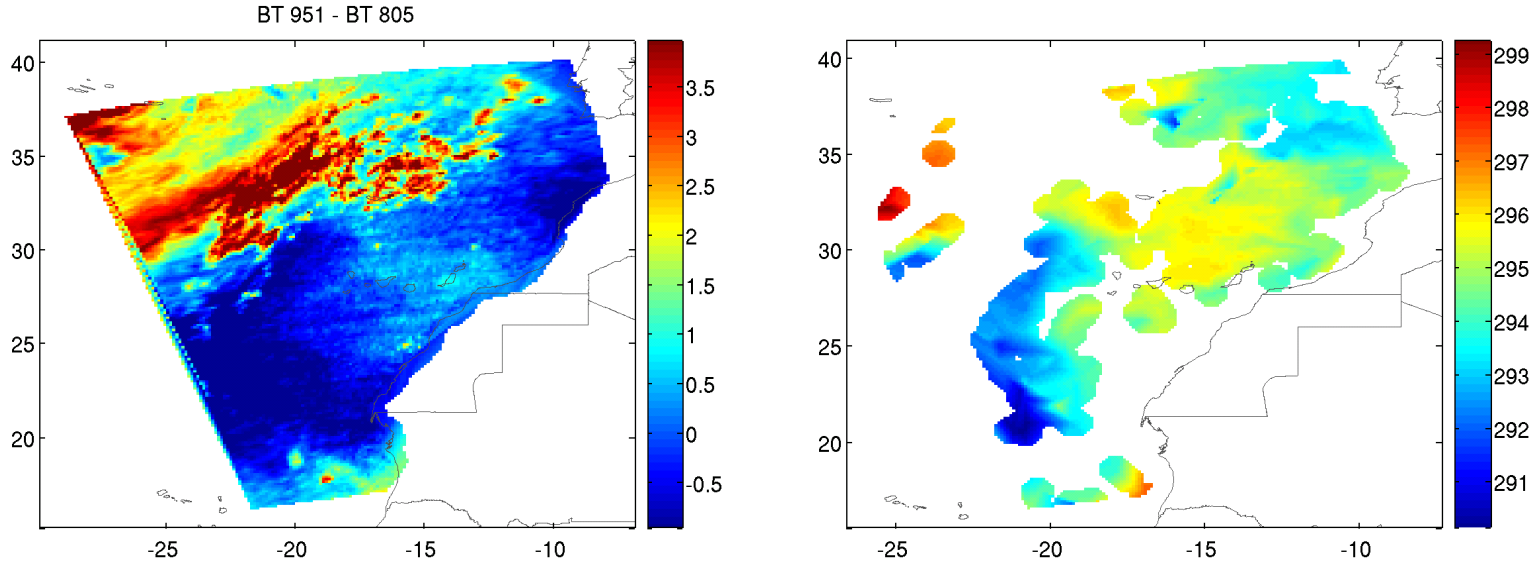
- Smaller MODIS footprints averaged onto a larger AIRS footprint
- MODIS channel 2 (0.55 um) optical depths compared to 11 um AIRS retrievals
- Biases for $0.2 \leq \tau_{900} \leq 0.5$
- V-shaped depression at 870 cm^{-1} for dust not present in standard dust refractive indices

July 25, 2004 (granule 143) Duststorm off W.Africa



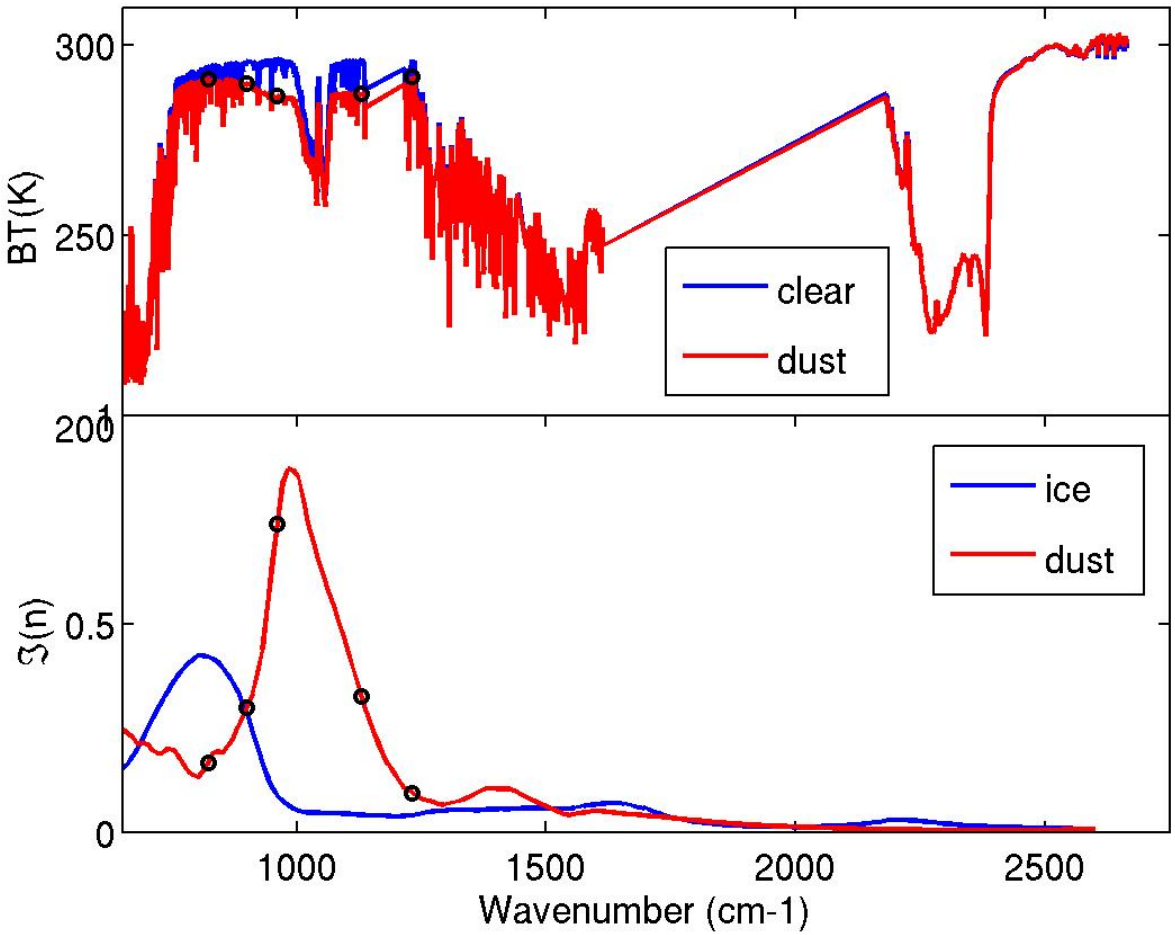
- AQUA-MODIS image of severe Duststorm, plus clouds, off W.Africa

Dust and cirrus signal in IR obs



- BT 951 - BT 805 plotted : red = cloud, blue = dust
- SST plot only shows FOVs that made it through our very tough “uniform-clear” filter.
- Dust is uniform enough that many FOVs make it through the filter test!

Channels used for dust flag

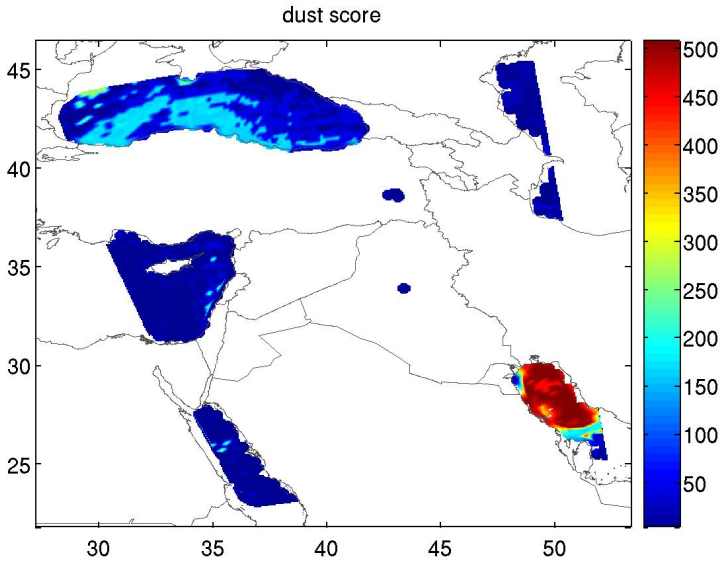


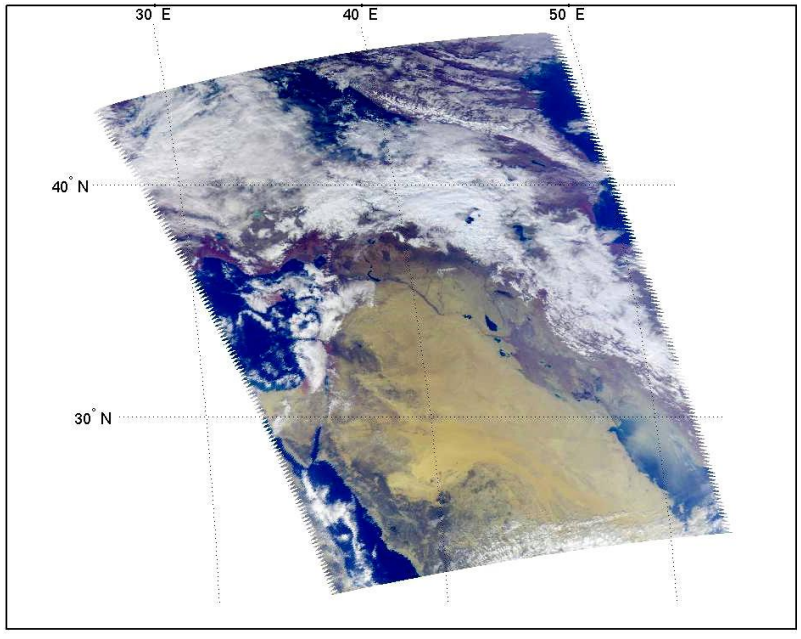
Dust Flags

- Use SARTA-CLOUDY code, as well as actual AIRS data, to set up a series of "threshold dust cloud tests" over ocean
- 5 channels chosen are [822.4 900.3 961.1 1129.03 1231.3] cm^{-1}
- Tests mainly involve split window brightness temperature differences
- Scores are accumulated depending on how stringent the tests are
- FOV is set as "dust contaminated" if score passes certain threshold

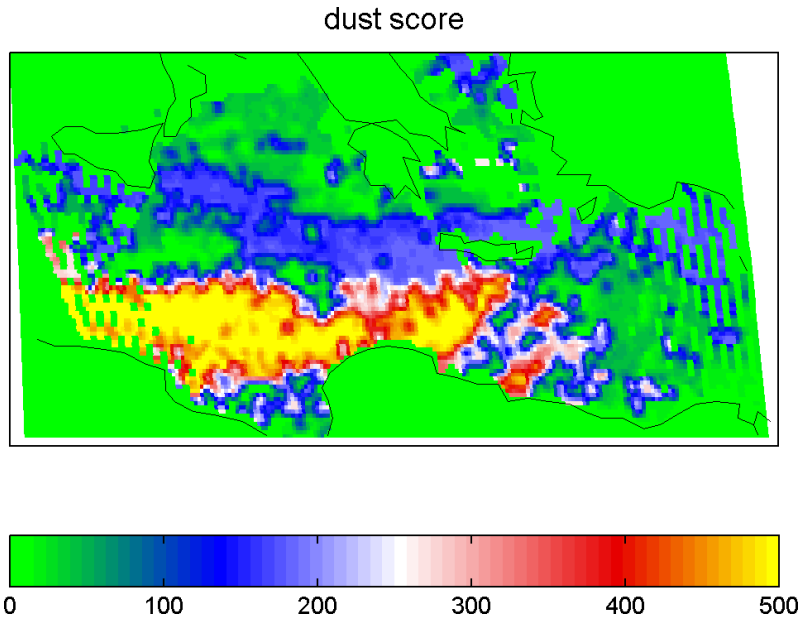
```
dust0 = find(zz24 gt -0.5  & zz24 lt 1.00);
dust1 = find(zz45 lt -1.25);
dust2 = find(zz41 lt -0.75);
dust3 = find(zz34 gt -0.2  & zz34 lt 1.0);
dust4 = find(zz25 gt -4.5  & zz25 lt -0.3);
dust5 = find(zz21 lt 0.115);
dust6 = find(zz23 gt 0.05 & zz23 lt 1.5);
dust7 = find(zz35 lt -0.15);
dust8 = find(zz31 lt 0.40);
```

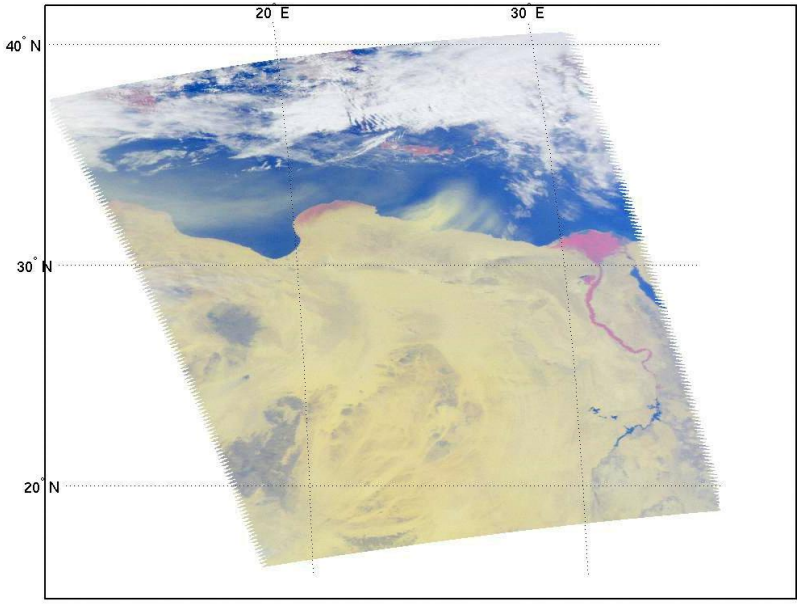
January 7, 2005 Duststorm in Persian Gulf



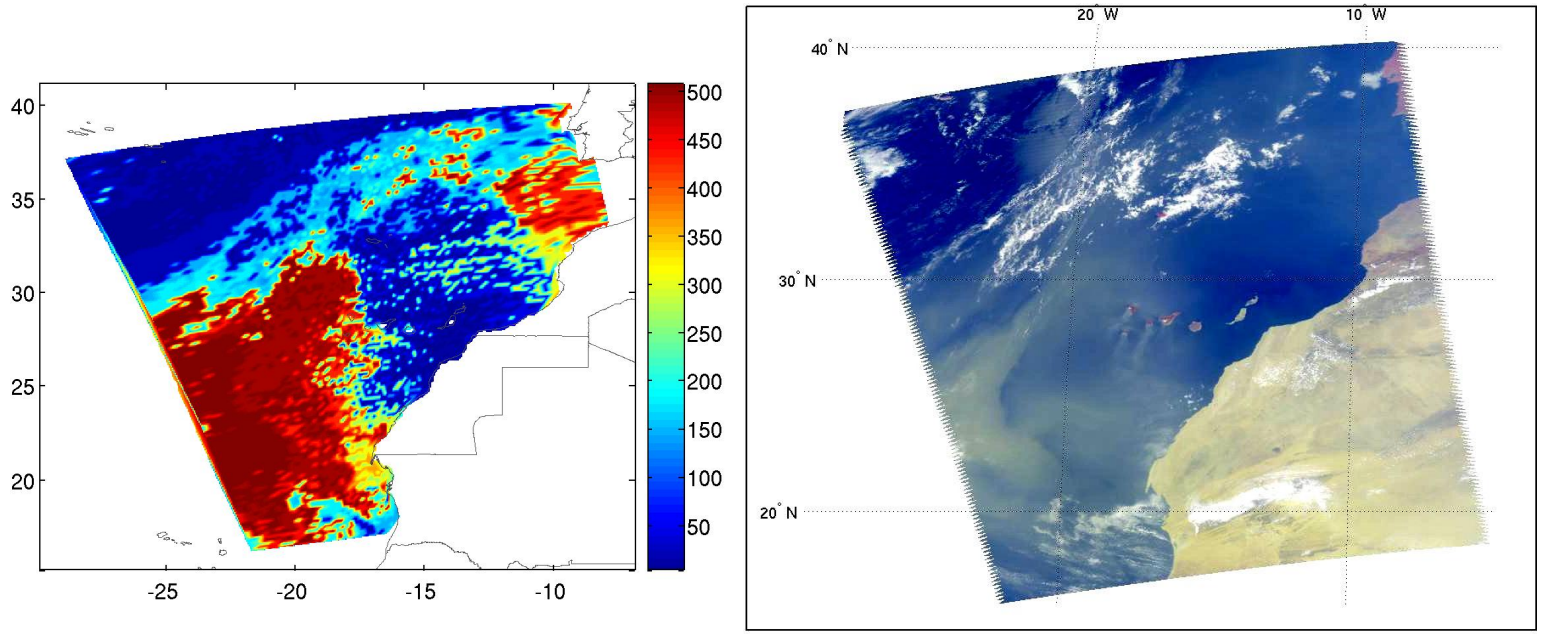


February 28, 2005 Duststorm off Libyan/Egyptian Coast

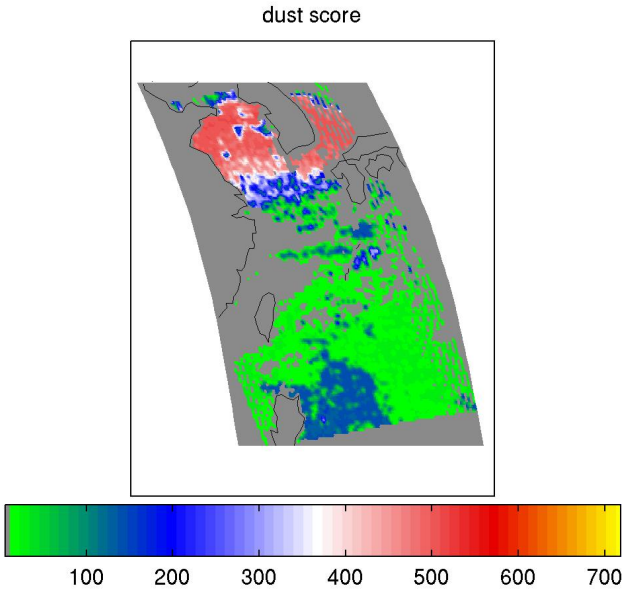


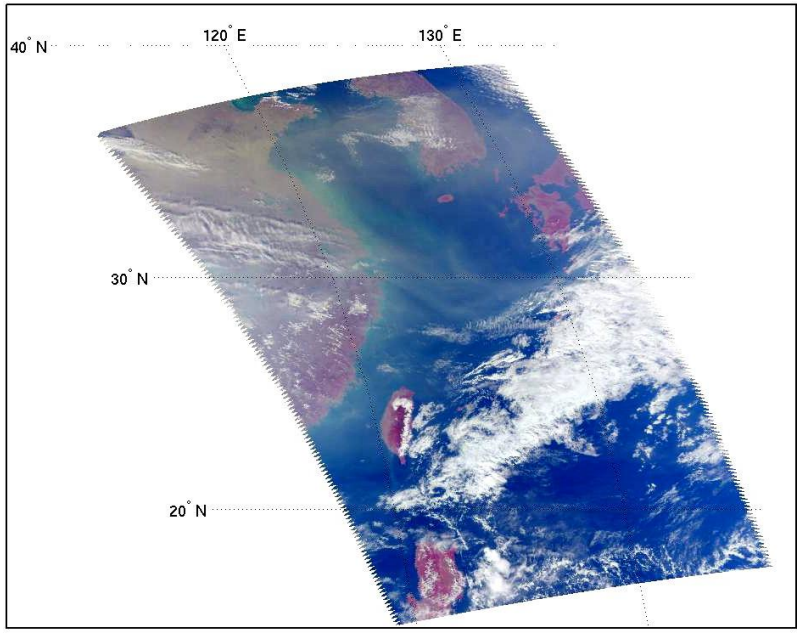


Jul 25, 2004 Duststorm off W. Africa : Dust Score

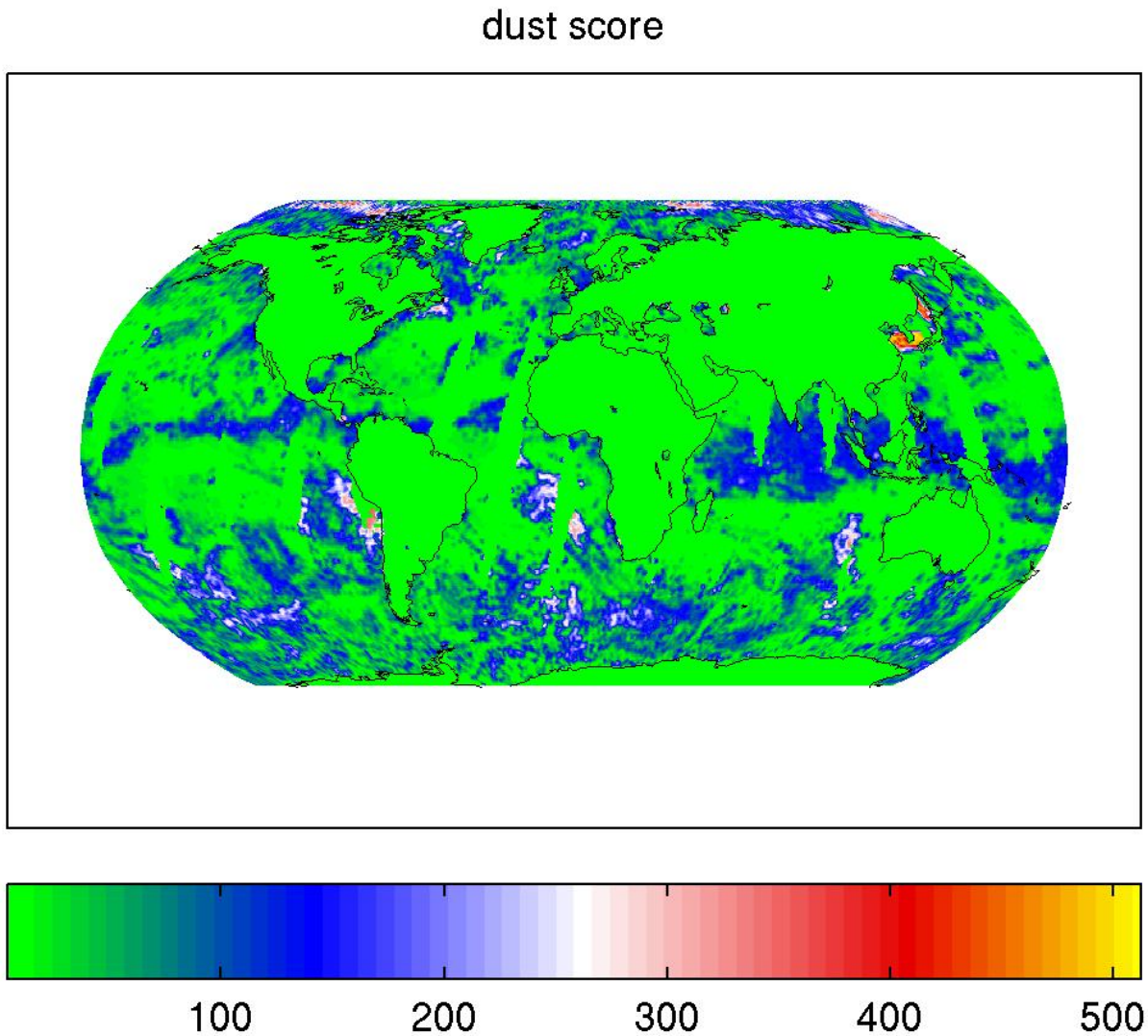


Nov 12, 2002 Duststorm off China : Dust map

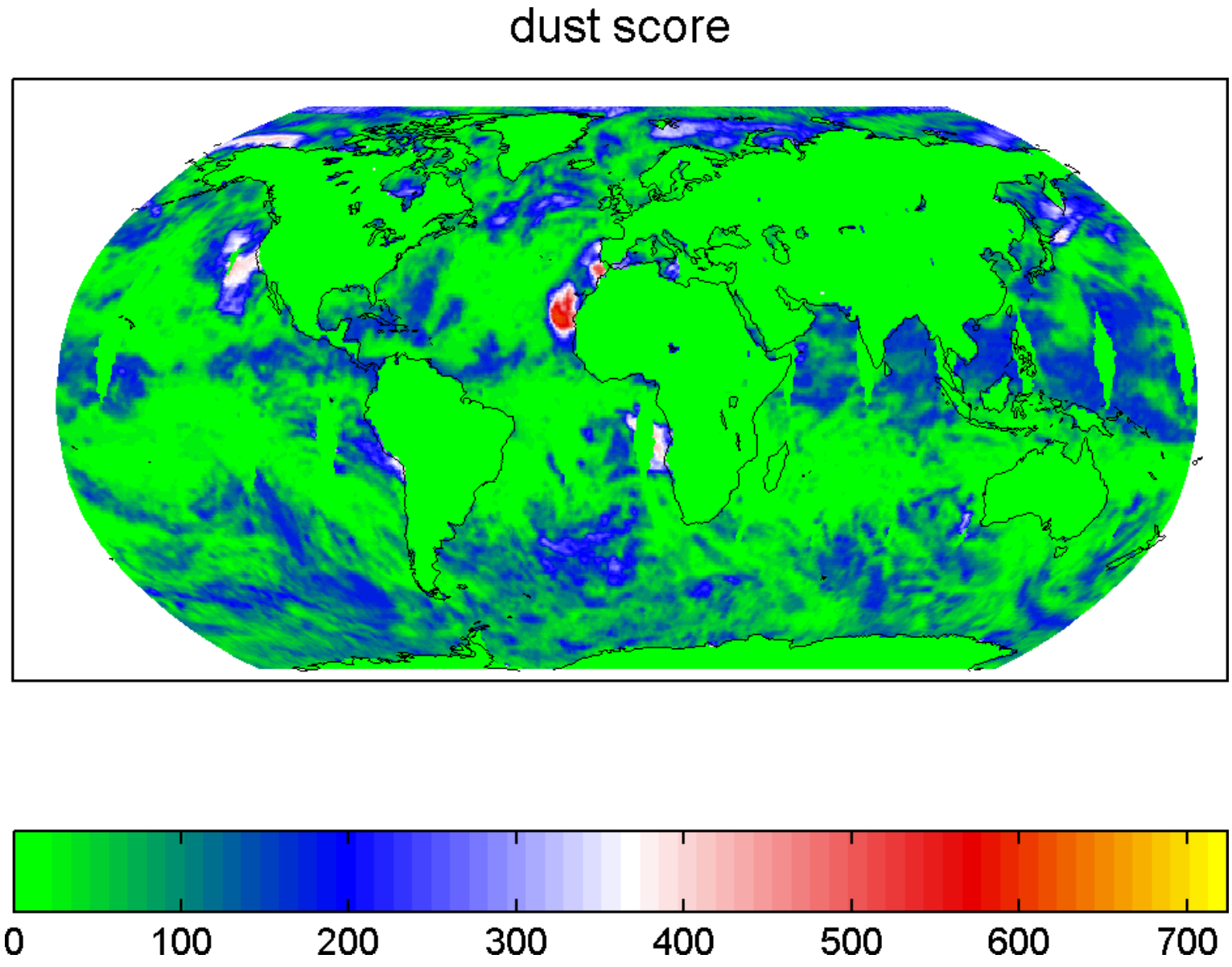




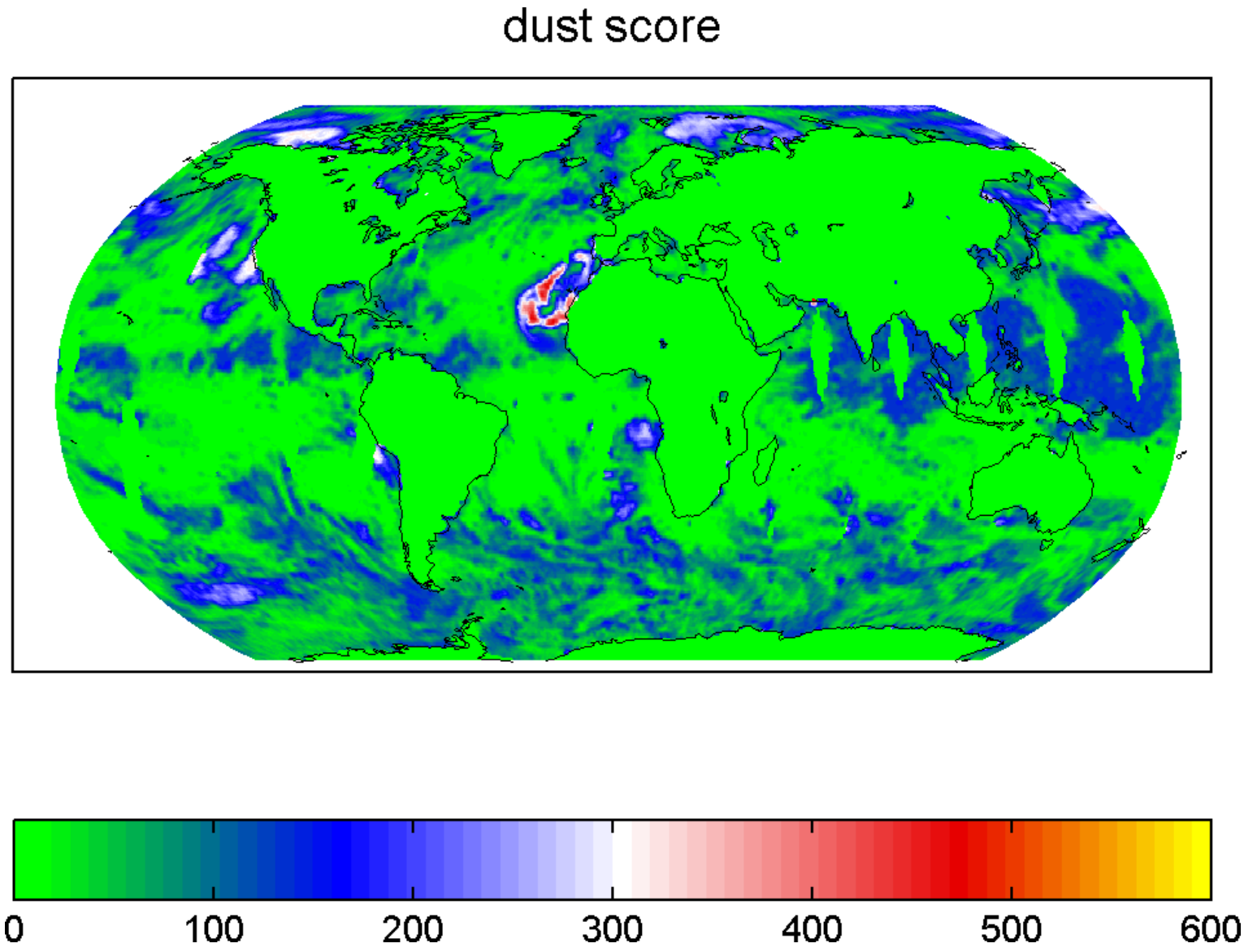
Global Score : Nov 12, 2002 China



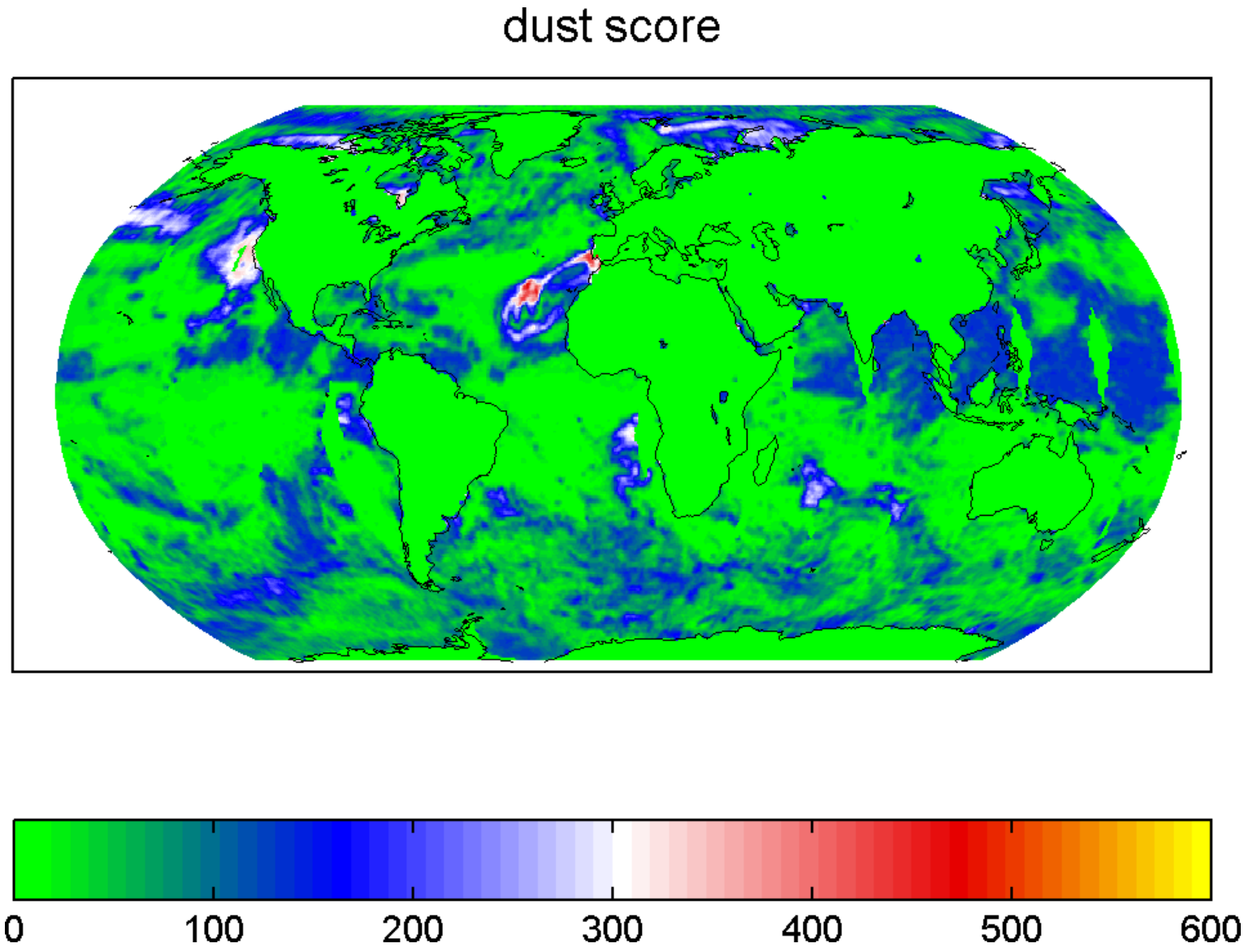
Global Score : July 25-27, 2004 W. Africa



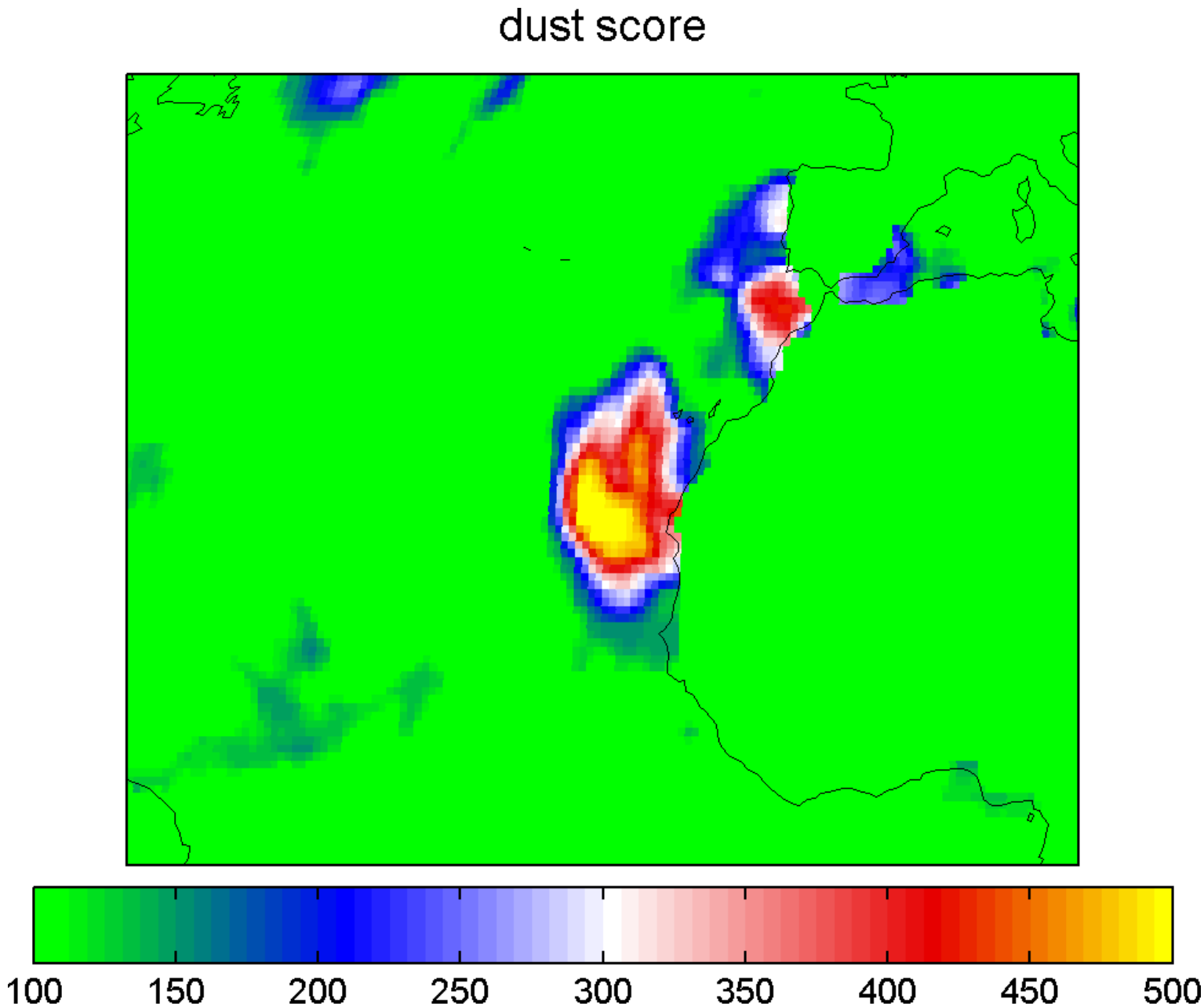
Global Score : July 25-27, 2004 W. Africa



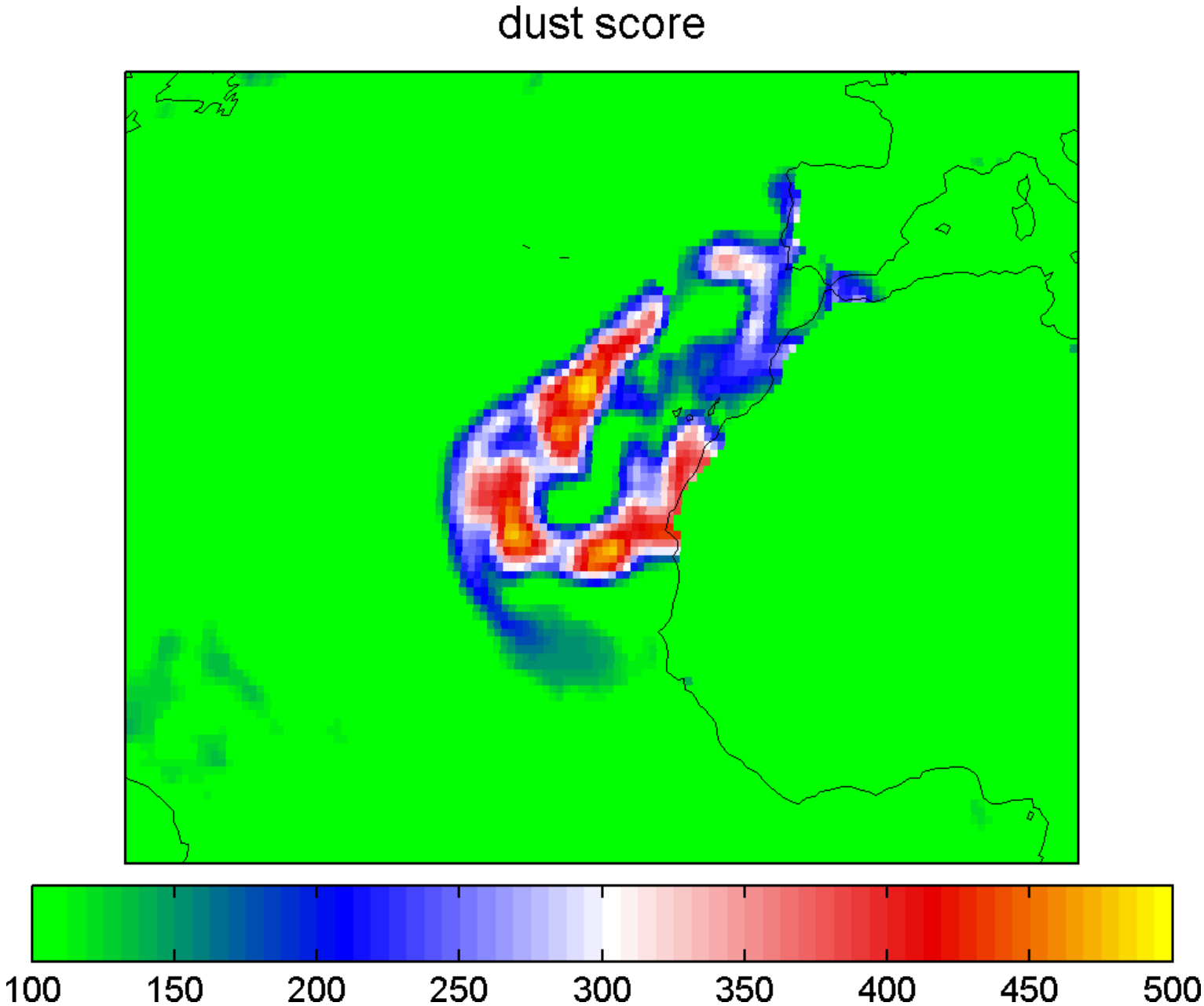
Global Score : July 25-27, 2004 W. Africa



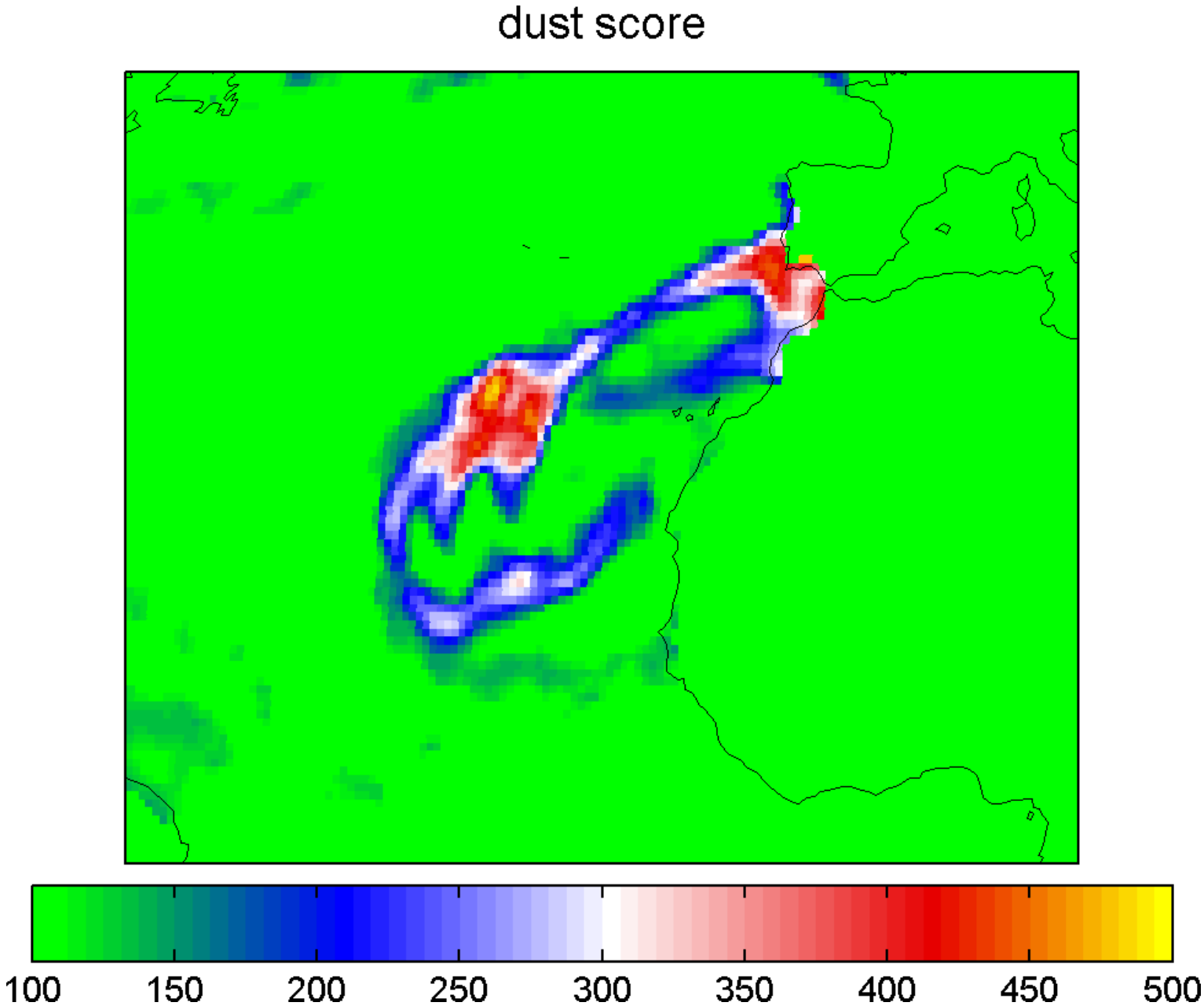
Global Score : July 25-27, 2004 W. Africa : Zoom in



Global Score : July 25-27, 2004 W. Africa : Zoom in



Global Score : July 25-27, 2004 W. Africa : Zoom in



Dust Retrievals

- Currently we use SARTA-CLOUDY code with ECMWF or AIRS-retrieval profile fields, to determine particle size/cloud loading
- Cloud top height and fraction come from AIRS-retrievals
- Using about 15 channels, this takes about 15 sec/profile on 2.6 GHz machine
- In the Thermal Infrared, dust particles are mainly absorbing, so we can speed up the code by just using the absorptive cloud optical depth added onto the atmospheric optical depth (from SARTA). This should significantly speed up the retrieval
- May look into a look-up table approach for dust optical depth retrievals

Dust Retrieval Validation

- We test the “absorption only” results against those from the complete “fast scattering code”, as well as against benchmark codes such as DISORT and RTSPEC
- Retrieved optical depths are compared (daytime only) to those derived from MODIS, and recently OMI on AURA.
- AEROSE campaign in March/April 2004 (Nick Nalli, NOAA) should help with validation.
- Brian Kahn (UCLA) and Frank Evans (author of RTSPEC, U of Colorado) are interested in participating in an intercomparison of scattering codes.

Summary

- Much more extensive testing needed on larger data sets
- Extend testing to CC'd radiances
- Develop fast optical depth algorithm - want to simplify software
- More work to determine how to handle dust cloud vertical extent, presently using AIRS cloud top height for CC'd radiance studies
- Examine errors in using single refractive index function for dust.